

ANNALS OF SURGERY

VOL. XLII

NOVEMBER, 1905

No. 5

ORIGINAL MEMOIRS.

A REVIEW OF FIVE HUNDRED CASES OF GASTRO-ENTEROSTOMY, INCLUDING PYLOROPLASTY, GASTRODUODENOSTOMY, AND GASTRO-JEJUNOSTOMY.¹

BY WILLIAM J. MAYO, M.D.,
OF ROCHESTER, MINN.,
Surgeon to St. Mary's Hospital.

THE writer has included in this series all of the cases in which there has been an incision made into both the intestine and stomach and plastic union established between the two organs with the intent to increase gastric drainage. The term gastro-enterostomy is used in its literal sense, the formation of an artificial passage between the stomach and intestine; the terms pyloroplasty, gastroduodenostomy, and gastrojejunostomy being used as expressing more accurately the exact method employed.

The series of cases have been worked out with a view of showing the actual results of operation both as to mortality and the percentage of secondary operations. The method of computing mortality herein followed is to charge as a death from operation every case dying in the hospital without regard to cause of death or length of time after. It includes cases dying as long as three months after operation, from coincident chronic nephritis, etc., and might be called the combined mor-

¹ Read before the American Surgical Association, July, 1905.

tality of operation and disease. This works a hardship on the statistics, but it eliminates the personal equation. The statistics include every case Dr. Charles H. Mayo and myself have operated upon up to June 20, 1905; the early cases showing a particularly high mortality. The secondary operations were repeated in some instances two to five times before good results were obtained, so that the number of such procedures was nearly double the number of cases reported.

Pyloroplasty, 21 cases. No deaths. Seven secondary operations ($33\frac{1}{3}$ per cent.). Gastroduodenostomy, Finney, 58 cases, four deaths (6.9 per cent.). Two secondary operations (3.4 per cent.).

Gastrojejunostomy. Total, 421. Benign, 307 cases, 19 deaths ($6\frac{1}{2}$ per cent.). In the last 140 there were four deaths, a mortality of $2\frac{6}{7}$ per cent.; last 80 gave but one death. One hundred and fourteen malignant, with twenty-one deaths (18 per cent.). Of these 114 cases, 63 were in connection with pylorotomy and partial gastrectomy, with eight deaths (13 per cent.). The very unfavorable cases of cancer obstruction were subjected to gastro-enterostomy, so that this operation gives a higher mortality than radical excision. In the last 40 gastrojejunostomies for malignant disease the mortality was 8 per cent. In the 421 gastrojejunostomies there were 21 reoperated cases (5 per cent.).

PYLOROPLASTY.

The pyloroplasty of Heineke-Mikulicz, in our experience, has but little risk in suitable cases, but it is open to objection. It enlarges the caliber as much in an upward direction as downward in the line of drainage, and the extent to which this enlargement can be carried out is limited. The pylorus, following this operation, is exceedingly prone to become adherent, so that the opening remains at a high level. The stomach, if greatly dilated, must elevate the food to the high lying outlet, and it frequently happens that the degenerated muscle fibres are incapable of the muscular effort, and, as a result, the patient is not materially benefited. In three cases

we fastened the pylorus, after operation, to the region of the umbilicus by suture, to secure a low drainage point, taking advantage of the fact that adhesion after operation was the rule, to secure fixation at a more favorable situation. These three cases have continued in good health, but there are valid objections to the plan. In the seven cases which came to secondary operation, the adhesions were most marked. Gastro-jejunosomy in each case resulted in cures. In the remaining 14 cases, cure resulted. In four cases, an ulcer was excised at the same time with favorable result. Pyloroplasty has a small field of usefulness, but in performing it the later plan of Mikuliez should be adopted. The incision should be curved downward upon both the stomach and duodenum, much like the Finney method, the result being to give an increased caliber over pyloroplasty as ordinarily performed, and establishing better drainage lines.

The principle in plastic union, established by pyloroplasty, is one of the first importance and widely used in surgery. It is especially valuable in choosing the line of closure after excising gastric ulcers, etc.

GASTRODUODENOSTOMY.

Strictly speaking, this operation implies a separate opening between the stomach and duodenum, such as the Kocher operation; but, as the method of Finney more easily answers the same purpose, we have followed this plan in the entire group of 58 operations, with four deaths and with two secondary operations. (Mortality, 6.9 per cent. Secondary operations, 3.4 per cent.) In the first 46 cases there was only one death, in the next 12 there were three deaths. It does not seem fair to count two of the deaths, as one was from pneumonia after complete recovery and one from embolus due to an old endocarditis. We had an opportunity to re-examine the operated field in three individuals after a number of months, there were extensive adhesions present in two.

Subjects for this operation should be carefully selected; extensive disease, adhesions, a short gastrohepatic omentum,

and especially the presence of scar tissue, should be considered a contraindication, as it is in just these varieties that gastrojejunostomy gives the most satisfactory results. Two of the four deaths we had were due to suture leakage on account of tension in scar tissue.

In open ulcer the food must still pass the ulcer area to reach the pylorus, and ulcer does not depend on obstruction, as shown by the frequency of duodenal ulcer beyond the possibility of obstruction. Reasoning on this ground, we would not expect the curative results from gastroduodenostomy in active ulcer which we would get from gastrojejunostomy made to the left of the ulcer-bearing area, and our experience bears this out; in this class of cases it has not given the same measure of relief. The importance of this objection is somewhat minimized by the fact that the line of enlargement is not only downward in the line of drainage, but also along the greater curvature, which is seldom involved in ulcer. The opening can be made of ample size, and it avoids the risks habitual to gastrojejunostomy, as it leaves the outlet at its proper situation. We were enabled, in four cases, to combine with the Finney operation an excision of the ulcer. In selected cases this Finney method is the one of choice.

There were two secondary operations in this group; in both individuals bile came into the stomach, causing distress. We had made the opening too large, as shown at reoperation. One case had severe hæmorrhage from insecure suturing, and required reoperation in twenty hours, with recovery.

GASTROJEJUNOSTOMY.

Gastrojejunostomy, 421 cases. Benign, 307 cases, 19 deaths (6 per cent.). Secondary operations, 20 (6½ per cent.). Malignant, 114 cases, 21 deaths (19 per cent.). One secondary operation 0.9 per cent.). Of these operations, 63 were made in connection with pylorectomy and partial gastrectomy.

The writer has been greatly interested in gastrojejunostomy. No operation in surgery has conferred greater benefit

upon suitable patients than this one. Unfortunate experience, however, sharpened the investigation as to the causes of deaths and the complications which we found to be more or less inherent in every method with which we became acquainted. In all but three of the fatal cases, a post-mortem examination as to the cause of death was obtained.

It has only been of late that we have secured a method which could be depended upon to give good results steadily with a sufficiently low mortality to justify its employment in cases in which disability, rather than impending death, was the spur to operative relief.

The first claim to investigation comes with the question, Shall the operation be made anterior after Wolfier, or posterior after von Hacker? Of the total number of cases, 126 were anterior and 295 posterior. The mortality in the anterior group was somewhat over 1 per cent. higher than in the posterior, but the percentage of secondary operations was greater after the posterior operation. The mortality comparison is, however, hardly fair to the anterior method, as this group comprises a larger number of the early operations in which inexperience can be blamed for some of the misfortunes.

For benign disease, the posterior operation is the one of choice. It is applied at a higher point on the jejunum, and is unattended with the risk pertaining to the presence of the loop which must surround the transverse colon. That this loop is of dangerous import is shown by two of our secondary operations, in one of which a number of feet of small intestine travelled through the noose, and in the second, death was directly traced to adhesion and obstruction of the transverse colon. The length of this loop is from sixteen to twenty inches, a disadvantage when one considers the proportionally high value of the upper jejunum in digestion and absorption. The anterior operation has some few indications. In cancer the disturbance is less, and, as the gastric juice has little acid, the patient cannot be expected to live long enough to develop a secondary jejunal ulcer. The anterior operation is more liable to be followed by contraction on account of the traction weight

of the attached jejunum, a diverticulum formation of the intestine takes place which is followed later by contraction. This happens most frequently after the button, as the line of union is narrow and it has less of a grasp on the tissues. Contraction, however, is liable to occur after any form of operation, especially if the pylorus is unobstructed. With an open pylorus nature tends to close the opening, no matter what form of operation; but the shorter the loop, the less the probability of contraction, and in the operations without a loop we would not consider it a serious question. We have seen a reduction of one-half take place three and five months, respectively, after a Moynihan operation on a nine-inch loop.

Vicious circle, as the regurgitant vomiting is generally known, is less liable after the anterior than the posterior operation. The traction weight of the attached intestine tends to keep the bowel pulled away from the stomach, while, after the posterior operation, there is a greater tendency for the development of a kink or flattening of the intestine against the opening (Cannon and Blake). In spite of the objections which we present to the anterior operation, we have a large number of operated cases after this method in perfect health for periods of time up to twelve years.

Angulation and obstruction are the two great causes of regurgitant vomiting, and, in our experience, the short, posterior loop of from seven to ten inches gave the greatest number of such complications. Acute, vicious circle occurs very rarely, if the opening be placed at the lowest point of the gastric cavity; but a considerable number of patients begin to have trouble, usually, within two or three months, as pointed out by Ochsner. This condition often increases, and in from six months to a year gives sufficient annoyance to require a secondary operation.

Murphy Button. Total, 157 operations. Benign, 72 operations, 6 deaths (8 per cent.), 54 anterior, 4 deaths (8 per cent.), 4 reoperations (8 per cent.). Eighteen posterior, 2 deaths (11 per cent.), 4 reoperations (22½ per cent.).

Malignant, 85 operations, 15 deaths (18 per cent.), including pylorotomy and partial gastrectomy.

The Murphy button is least liable to be followed by passage of bile into the stomach. While in position, it mechanically prevents kinking, and the character of the permanent opening does not favor angulation. Four of the deaths were caused by pulling apart of the attached surfaces in from six to ten days subsequent to operation, and after the button had passed along the intestine. We now always protect the button union by four or five mattress sutures of silk at intervals. A continuous suture outside the button may prevent its passing out of position and cause it to lodge and act as a foreign body. If it were not for the frequent retention of the button in the stomach, the posterior button method, without a loop, would be ideal. Twice we have had to remove a retained button for symptoms. After pylorotomy and partial gastrectomy for cancer, we nearly always employ the button. It gives an immediate opening and is particularly free from secondary complications. In one out of three direct anastomoses by the Kocher method, between the duodenum and stomach after partial gastrectomy, a second operation was required in eight weeks to relieve angulation and obstruction.

McGraw Ligature. Total, 36 operations. Benign, 17, 2 deaths (11.7 per cent.). Malignant, 19, 3 deaths (15.7 per cent.). We have used Ochsner's technique and found it very satisfactory.

The McGraw ligature method anterior has been very free from bile regurgitation and is exceedingly safe. It can be placed in bad tissues and can be used in poor subjects. We have four times used this operation with a hæmoglobin of less than 25 per cent.; once 20 and once 24 per cent., in bleeding ulcer, with recovery; once with the hæmoglobin 24 per cent. in cancer with acute obstruction, with recovery; once with hæmoglobin of 10 per cent. in cancer with hæmorrhages simulating ulcer. The latter case was scarcely conscious at time of operation. He lived three days, and, although a stout, heavy rubber cord was used and tightly tied, there was no sign of an opening at the postmortem. It requires some vitality to cause the tissue to cut through. This man did not

have sufficient resistance to set up atrophy necrosis, and the result was the same as in a cadaver. Two cases of cancerous obstruction with a considerable quantity of free fluid in the abdomen recovered after a ligature operation. Tissues which are of poor vitality, but which have some power of repair, will do so after a McGraw ligature. The button might set up an uncircumscribed slough, or the suture become easily infected, if these methods were chosen. The McGraw operation, including opening and closing the abdomen, can be done in twelve minutes, without hurry. The disadvantages are, that it should be, or has been, used with the loop, and, like any loop operation, the opening may contract. Again, it does not allow of immediate feeding. This fact and the uncertainty of the time of the ligature cutting through render the method one for the occasional rather than the average case. We had one case of acute regurgitant vomiting after the McGraw ligature, which was reoperated on the fourth day. The ligature had been badly placed and the opening lay at one side of the centre of the bowel.

Posterior Suture.—Total, 228 operations. Ten malignant, with 2 deaths (20 per cent.). Two hundred and eighteen benign, with 11 deaths (5 per cent.).

We do not do an anterior suture operation. The increased risk of contraction and jejunal ulcer which unavoidably attends the anterior method would, with the suture, also increase the chances of bile regurgitation.

In May, 1901, Mr. Robson demonstrated in this country the bone bobbin operation, with the suture on a posterior ten-inch loop. We did fifteen by this method, with one death, and found it very satisfactory.

In June, 1903, we began the method of Mikulicz, making the opening within three or four inches of the origin of the jejunum and using a transverse incision. We made forty-three by this method with four deaths, two of which could be fairly excluded. Four required a second operation at our hands, and to a large extent because we departed from the originator's technique. It came about in this way: The transverse intes-

tinal incision limits the size of the opening to one-half the diameter of the intestine, less about one-fourth inch suture line, and the opening could seldom be made larger than could admit the invaginated thumb. We tried to enlarge this by encroaching on the bowel, and caused a valve to form, which turned the bile into the stomach. These patients gave us a lot of trouble, the short upper limb of the loop made an ordinary entero-anastomosis of the two arms of the bowel impossible. We finally united the intestine each side of the opening in exactly the same manner as the Finney operation at the pylorus. The result was good. This was our first experience with the short proximal loop; the cases which recovered after this method have remained in splendid condition, despite the small opening. In October, 1903, Dr. Charles H. Mayo did two operations with a longitudinal, intestinal opening without a loop and as short as possible, practically the operation we are doing now. Both recovered and remain well.

In the summer of 1903 Mr. Moynihan demonstrated to us the method he was using with the clamp, and which goes by the name of the "Moynihan Operation," using the oblique, posterior incision of the stomach wall and a nine-inch loop. The use of the clamps simplified the technique, and the opening could be made very large. We made fifty-three after this method with three deaths. The primary results with the Moynihan operation were good. Not a case of acute vicious circle, but in the course of a year seven cases required a second operation for the distress caused by bile regurgitation, either occasionally in large quantities or frequently in smaller amount. In June, 1904, we began the operation on the Roux principle, doing a posterior gastro-enterostomy on a nine-inch loop with entero-anastomosis. The proximal loop was then obstructed (*a*) by Scott-Matolli suture, (*b*) Fowler's silver wire, (*c*) division of intestine, turning in both ends after Doyon. There were forty-eight of these, with two deaths. Two required a second operation, in one the silk suture in the longitudinal pleating had passed into the intestine. The infection caused adhesions, angulation, and bile regurgitation. In the second, in which the

proximal intestine had been divided, the cut end intussuscepted through the upper part of the lateral anastomosis, causing obstruction. This complicated operation was of too serious a character to apply to every case, requiring from forty-five to fifty minutes for its performance, and on January 1, 1905, we began the routine use of the posterior suture operation without a loop, in the same manner as used in the two cases operated upon by Dr. Charles H. Mayo in October, 1903.

The operation of choice is without a loop. Fifty-six operations, 1 death (1.8 per cent.).

This operation became popularized by the writings of Peterson, of the Heidelberg clinic, Czerny having used it for years, usually with the Murphy button, and with splendid success. At the time Peterson brought out the favorable features of the method, we had practically abandoned the button for the suture in benign disease, and the operation could not be easily done with a longitudinal opening without the holding clamps, which Moynihan and Littlefield later popularized. Mikuliez, as already pointed out, was doing the operation with the transverse incision.

To properly appreciate the advantages of the "no loop" method, some physiological and anatomical facts must be understood (Fig. 1). The stomach is not a bag, but a muscular organ, and when empty the pylorus is not far from the lowest point, and lies nearly in the median line of the body. As the stomach distends, the organ becomes more nearly horizontal by the elongation of the greater curvature. The pylorus passes to the right of the median line and relatively passes above the greater curvature. The gastro-epiploic artery sets away from the greater curvature about three-fourth of an inch, when the stomach is empty, and sends its gastric branches upward on the anterior and posterior gastric wall, which it meets above the actual line of the greater curvature. This arrangement of the blood-vessels enables rapid distention of the stomach, without interference with the blood-supply. The lesser gastric curvature is more fixed in position and can be divided into two parts; the perpendicular portion which drops



FIG. 1.—Showing posterior wall of the stomach drawn through a rent in the transverse mesocolon. Note slight separation of gastrocolic omentum from its attachment to the stomach, permitting anterior wall of stomach to appear, and insuring drainage at lowermost level. Black lines mark site of proposed anastomosis; the jejunum shows at its origin.

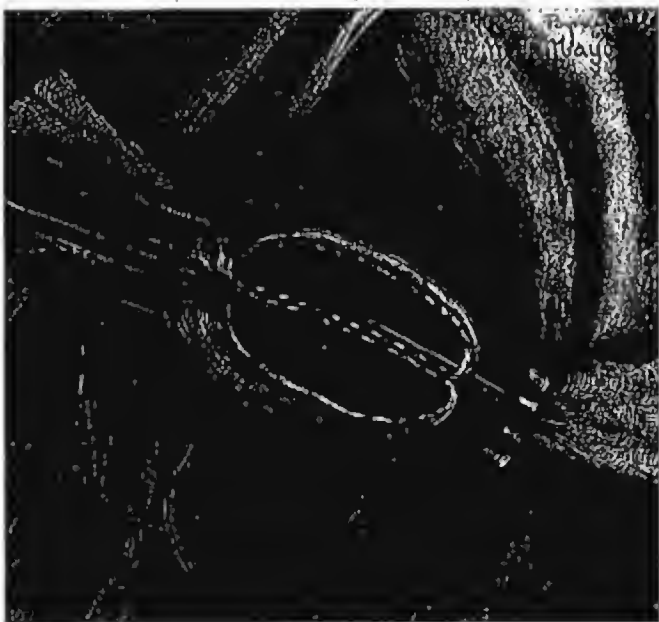


FIG. 2.—Forceps in place and anastomosis half completed by suture.

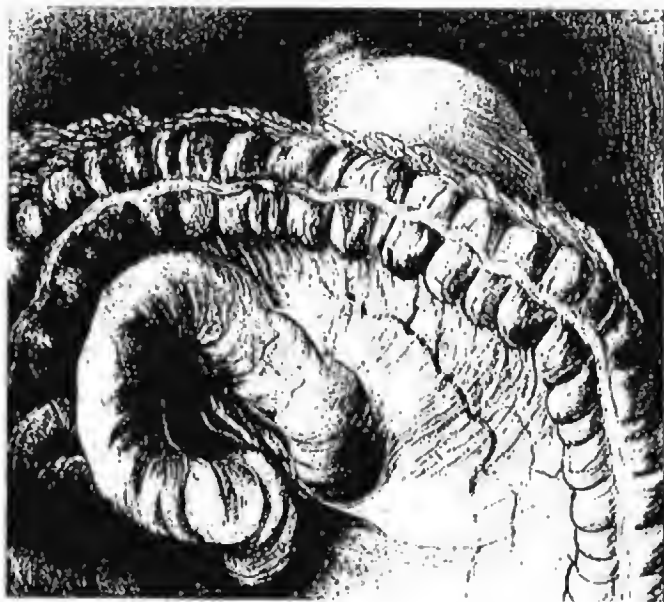


FIG. 3.—Completed operation from behind margin of torn mesocolon attached by several interrupted sutures to line of union,

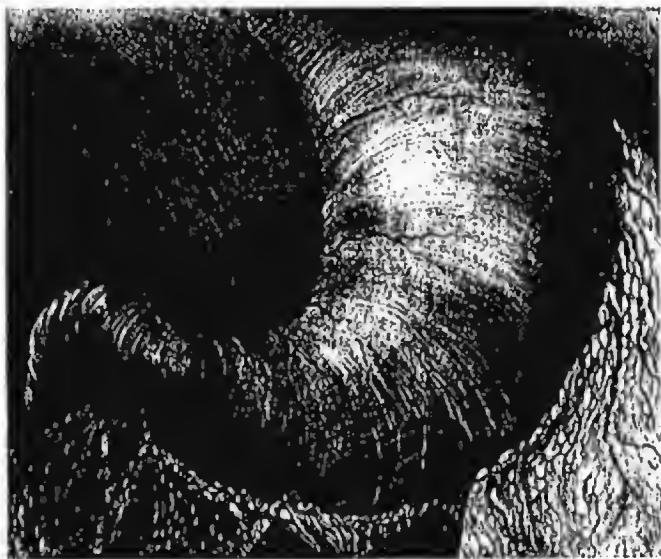


FIG. 4.—Completed operation from in front. Anastomotic opening shows through as darkened area on posterior wall. Note that it goes to the bottom of the gastric cavity and slightly anterior, as indicated by suture line in the omental attachment.

nearly vertically from the right margin of the cardiac orifice (about one and one-half inches to the left of the mid-line), and the horizontal or slightly curved portion, which turns sharply to the right and ends at the pylorus. Ordinarily, the concavity of the lesser curvature is from two to three inches, the corresponding point on the greater curvature being three and one-half to four and one-half inches, making the convexity of the pyloric segment. This is the grinding muscular portion of the stomach, the part subjected to the greatest amount of traumatism, and over 80 per cent. of all the lesions for which we are called to operate are either in this part or in the first two and one-half inches of the duodenum. The gastrojejunal opening should be placed just to the left of this portion of the stomach (Fig. 2). The inferior margin of the gastrojejunostomy should lie at the greater curvature, on a line opposite the juncture of the transverse and longitudinal parts of the lesser curvature. This is rather farther to the right than has usually been practised. The duodenum passes through the mesocolon, nearly on a perpendicular plane with the cardiac orifice, one and one-half inches to the left of the mid-line, and when the stomach is empty its lower border lies nearly on a line with the origin of the jejunum. When the gastric cavity is distended or dilated, it descends and covers this point. The proper situation of the gastric opening should be oblique on the posterior wall, beginning on the body of the stomach between the lesser and greater curvatures, and extending downward to the very bottom of the stomach—Moynihan's line (Figs. 2 and 3). To insure that the opening shall be at the very lowest point at its right margin, we slightly separate the omentum from the greater curvature and pull one-fourth inch of the anterior wall out posteriorly, pushing the gastro-epiploic vessel out of the way (Fig. 4).

In previous contributions to this subject we have called attention to the changed nature of the proximal arm of the jejunal loop after gastrojejunostomy. It becomes succulent and thick. With the loop operation, the food could and did pass into the proximal arm, while the peristalsis of this short

end was inefficient, and herein lay most of the difficulties. Peterson developed the fact that if the jejunum were attached short without a loop, it would require a reverse peristalsis to carry food into the duodenum. Peterson's point of jejunal election lies within from one to three inches of the origin of the jejunum, varying as necessary to enable easy attachment to the stomach (Figs. 1 and 2). It will be noted that the line of proposed union is a natural one. The jejunum attaches to the stomach without kink or bend in the line of gastric activity (distention and contraction). The intestine comes off the bottom of the stomach as though it were mortised on, the opening extending upward and to the left. As Cannon and Blake have experimentally proven, and we have clinically demonstrated, the food will pass out of the unobstructed pylorus after any method of gastrojejunostomy; with this method of operation it makes little difference. Spasm of the whole pyloric end of the stomach which quickly follows ulcer or other irritation no longer holds back the food and secretions. The gentle compressing action of the cardiac end is quite sufficient to turn the secretions and delayed ingesta out the gastrojejunostomy. Relief of the pyloric obstruction, no matter its character, permits normal progress. Interruption of this calls the new opening into use. It is not at all necessary for the chyme to enter the duodenum to stimulate pancreatic and biliary discharge. This happens whenever the gastric product enters the small intestine at any point. In all the loop operations, more or less of the jejunum, at its most important situation, is thrown into a by-channel. The opening of the common duct lies four inches below the normal pyloric entrance of food. This operation brings the common duct opening eight inches above the gastrojejunal food entrance, and the constant presence of biliary and pancreatic alkaline secretions will certainly render secondary jejunal less frequent than primary duodenal ulcer.

To recapitulate:

(1) The gastric opening should be placed on the posterior wall, obliquely from above downward, and left to right (Fig. 1). (Moynihan's line.)

(2) The lowest point of the gastrojejunostomy should be at the lowest point of the stomach, on a plane perpendicular with the cardiac orifice (Fig. 1).

(3) To insure this effect, the gastric incision should extend one-fourth to one-half of an inch onto the anterior wall (Nos. 1, 2, 3, and 4).

(4) The incision in the intestine should be longitudinal, opposite the mesentery, and begin from one to three inches from the origin of the jejunum, measuring on the anterior surface. (Peterson's point of election, Figs. 1, 2, and 3.) The exact distance depends on the ease of attachment, as short as can be conveniently done without tension.

A description of the operation is, briefly, as follows:

(a) The abdominal incision is made four inches in length, three-fourths inches to the right of the middle line, the fibres of the rectus muscle being separated. The lower end of the external wound lies opposite the umbilicus. This opening also enables inspection of the duodenum and gall-bladder and is reliable against hernia when closed.

(b) The transverse colon is pulled out and the mesocolon made taut by traction upward and to the right, in this manner bringing the jejunum into view at its origin.

(c) About three to four inches of the jejunum opposite the mesentery are drawn into a slightly curved clamp. The handles of the clamps should be to the right, to enable a short grasp on the intestine. Three-fourths of the circumference of the bowel is pulled through; the posterior border is not included, to prevent entanglement of the suture with the redundant posterior mucous membrane. The holding clamps are applied sufficiently tight to check hæmorrhage and prevent extravasation of intestinal contents.

(d) The ligament of Treitz is a short muscular mesentery covered by a variable peritoneal fold (too variable for a reliable landmark) extending upward from the origin of the jejunum on to the mesocolon. This peritoneal fold lies at the base of the arterial loop of the middle colic artery which supplies the transverse colon. The mesocolon is opened within the vas-

cular loop and the posterior inferior border of the stomach pushed through. A small separation of the greater omental attachment to the stomach enables the anterior gastric wall to be drawn out posteriorly. The posterior gastric wall is drawn into a clamp, with the handles to the right, in such a manner as to just expose the anterior wall at the base.

(e) The two clamps are laid side by side and the field carefully protected by moist gauze pads. With fine, celluloidal linen thread, on a straight needle, the intestine is sutured to the stomach from left to right by a Cushing suture at least two and one-half inches.

(f) The stomach and intestine are incised one-sixth inch in front of the suture line and the redundant mucous membrane excised flush with the retracted peritoneal and muscular coats. With a No. 1 chromic catgut on a straight needle, the posterior cut margins of the entire thickness of the gastric and jejunal wall are united by a button-hole suture from right to left; at the extreme left the suture changes to one which passes through all the coats, of each side alternately, from the peritoneal to the mucus, then directly back on the same side from the mucus to the peritoneum. This acts as a hæmostatic suture, and also turns the peritoneal coats into apposition. It passes around the anterior surface and is tied to the original end, which has been left long for the purpose. If silk or linen is used for this suture, it may hang *in situ*, suppurating for months.

(g) The clamps are now removed and the linen thread continued around until it is tied to the original end, firmly catching the blood-vessels in sight along the suture line. The parts are carefully cleansed and inspected. If necessary, a suture or two is applied, to accurately coapt or to check the oozing.

(h) The margins of the incised mesocolon are now united to the suture line by three or four interrupted sutures, and the parts returned into the abdomen.

After-Treatment.—On being placed in bed, a glass female douche point is passed just above the internal sphincter ani.

attached to a gravity bag filled with one-half strength normal salt solution. The elevation should not be greater than six inches. The small stream passing into the rectum is readily absorbed without irritation. One or two quarts are taken up in an hour. (Murphy.) The patient is then placed in the semi-sitting posture. Beginning at sixteen to twenty hours, an ounce of hot water is given every hour; this is rapidly increased, and in thirty-six hours the usual experimentation with liquid feeding is instituted. Rectal feeding is unnecessary. The operation is, in all of its essential parts, that of Mr. Moynihan.

We are much indebted to Munro and Bottomly, of the Carney Hospital, Boston, for suggestions in technique, as elaborated above, and for the opportunity they have afforded Miss Burns to make the drawings, herein shown, from actual operations at their hands.